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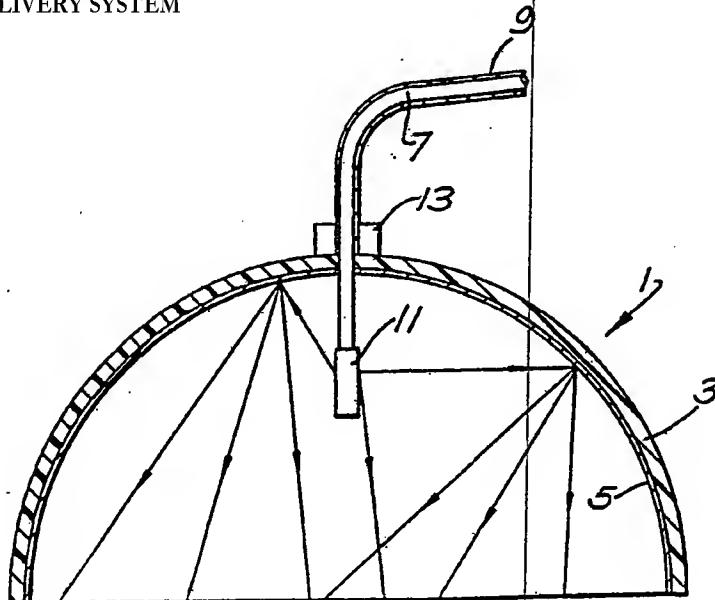
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(54) Title: LIGHT DELIVERY SYSTEM



(57) Abstract

A device for uniformly irradiating an area of a surface which accurately reflects lights reflected from the area and scatters it back towards the surface. The device is coated with a diffuse reflector and a light source (11) mounted in the shell (3) connected to a laser remote from the shell (3) via an optical fibre (7). In use the illumination so that the edges of the shell (3) define the area under illumination and the shell prevents any escape of light. A deformable sheet of partly reflective and the open mouth of the hemisphere to cover the target area to increase the uniformity of illumination when the device is used on uneven surfaces. The device is particularly useful in photodynamic therapy.

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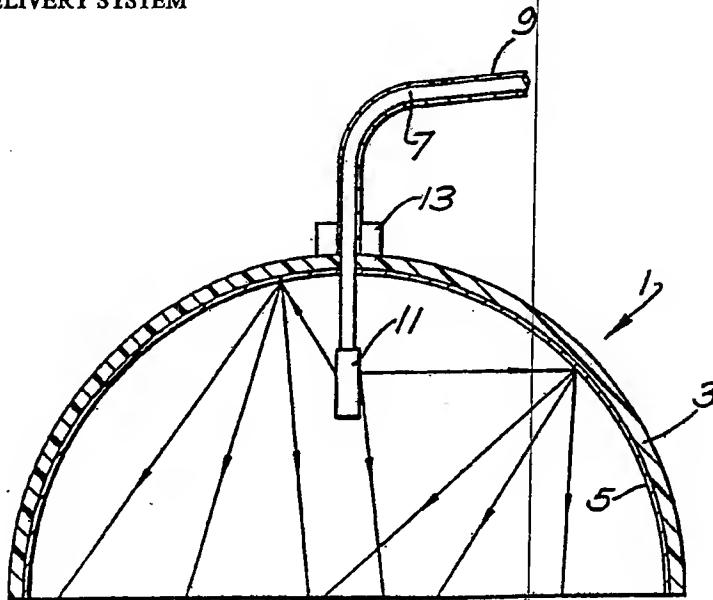
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(57) Abstract

A device for uniformly irradiating an area of a surface which accurately defines the area under irradiation and collects lights reflected from the area and scatters it back towards the surface. The device comprises a hemispherical shell (3) whose inside surface is coated with a diffuse reflector and a light source (11) mounted in the shell. The light source may be a diffusing device connected to a laser remote from the shell (3) via an optical fibre (7). In use the shell (3) is placed against the surface under illumination so that the edges of the shell (3) define the area under illumination and the use of the diffusely reflecting surface of the shell prevents any escape of light. A deformable sheet of partly reflective and partly transmissive material may be placed across the open mouth of the hemisphere to cover the target area to increase the uniformity of illumination when the device is used on uneven surfaces. The device is particularly useful in photodynamic therapy.

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### LIGHT DELIVERY SYSTEM

This invention relates to an apparatus and method for illuminating an area of an object and in particular to a device in which the total amount of luminant energy delivered to the area can be accurately determined. It is particularly applicable to medical treatment techniques which rely on the illumination of body tissue in order to achieve desired effects e.g. photodynamic therapy and bio-stimulation.

It has been found that certain types of cancer including skin cancer and breast cancer can be successfully treated using a technique known as PDT. In this technique a photosensitizing agent, usually administered to the patient and this agent concentrates in the tumour because it leaks out of the vasculature surrounding the tumour tissue. The tumour is not as efficient at removing the lymphatic system in the rest of the body than in the rest of the body. At a certain time period there is proportionally more HpD in the tumour than in the rest of the body. At some point in that time period the area of the body with irradiated with laser light having wavelength of about 630 nm.

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nm! from! an! argon aye laser.'! The! effec  
on! the! OpD! is! to! cause! oxygen! radicals  
destroy! the! surrounding! tumour! tissue.  
breast! cancer! the! illumination! stage! o  
usually! given! twenty-four! to! seventy-two! hours! after  
administration! of! the! HpD! agent,! though with! skin! cancer,  
laser treatment! can! be delivered! up! to three! or! four! weeks  
after! the! administration! of! the! HpD.

of! the! laser! light  
to! be! released! which  
In! the! case! of  
the! treatment is

Conventionally! the! treatment! a! ea! has! been  
illuminated! using! laser! light! directed down! an! optical  
fibre,! the! tip! of! the! fibre! being! moved over! the! treatment  
area. One! problem! with! this! method! is that! the! illumination  
consists! of! an! intense! centre! spot! with the! intensity  
falling! away! gradually! from! the! centre of! the! spot.! This  
means! that! it! is! difficult! to! give! an! even! dosage! of! light  
to! a! large! area\_. Furthermore,! it! is! vry! easy! to! apply! too  
much! light! to! some! areas.! In! order! to! attempt! to! alleviate  
this! problem! it! has! been! proposed! to! deliver! the! light! using  
an! optical! fibre! bundle! with! micro-lenses! on! the! end! of! each  
fibre! or! diffusers! in! the! light! path! to! give! a! broader,! more  
even,! illumination! 'area. Another! proposal! is! to! control! the  
intensity! profile! of! the! beam! emerging! from! an! optical! fibre  
by! interposing! an! oblique! glass! plate! between! the! laser! and  
the! optical! fibre.

A! further! problem,! which! also! occurs! with! the

-! 3! -

improved! techniques! mentioned! above, is, however,! that! since the! surface! of! the body! being! illumina::ed is to! some! extent reflective,! it! is! difficult! to! determine! exactly! how! much light! is! absorbed! to! act! on! the! HpD.! The! reflectivity! of different! parts! of! the! treatment! area! nay! vary! and! so! even dosage! estimates! based! on! an! estimated! or! measured reflectivity! are! not! particularly! good A! typical! dosage estimate! with! one! of! the! techniques! ab.ve! was! that! 30-400 J/cm<sup>2</sup> was! delivered! to! the! patient.! I '! can! be! seen! that! the upper limit! of! the! range! is! over! ten! t! mes! the! lower! limit and! this! is! unsatisfactory! both! from! t! e! point! of! view! of that! treatment! and! for **statistically** processing! the! results from! many! treatments! to! try! to! improve! the! technique.

It! has! also! been! proposed! to! u! e! laser! light! in other! medical! treatments,! e.g.! bio-sti! ulation! in! which tissue! is! irradiated! with! low! power! laser! light.! It! has been! suggested! that! this! irradiation! h-s! certain! beneficial effects! and! has! been! used! to! speed-up! he! healing! of! wounds, as! a! beauty! treatment! and! in! physiothe..! apy.! Laser illumination! has! also! been! used! in! the! treatment! of! vascular **abnormalities** such! as! port! wine! stain! nd! the! removal! of tattoos. Other! types! of! light **have** al! o! been! used,! for instance,! infra **red!** or! **ultra!** **violet** for! treating! various onditions! e.g.! the! treatment! of! skin! disorders! e.g. psoriasis. In! some! of! these! agents! whi! h! render! the **skin**

4! -

sensitive! to! the! particular! light! bein<sup>g</sup> used! have! been  
**administered** to! the **patient**. **However**, similar! problems! with  
achieving! a! uniform **illumination** and! calculating! the! amount  
of! light! delivered! to! the! surface! have! been! found.

The! present! invention! provides! a! device! to! deliver! a  
defined **quantity** of! light! to! a **surface! comprising** a! light  
source! for! illuminating! the! surface! and! means! for! scattering  
light! reflected! from! the! surface! so! that! it! can! be! directed  
back! onto! the! surface!. Preferably! the! scattering! means! are  
adapted! to! provide! ..a! substantially! uniform! illumination! of  
the! surface.

In! more! detail! the! present! invention! provides  
apparatus! for **illuminating** an! area! of! an! object!,! comprising  
a! delivery! device! including! a! light! source! for! illuminating  
the! area! and! a! concave **diffusely** reflecting **surface**, wherein  
the! diffuse! reflecting! surface! is! adapted! to! define! the! area  
to! be! illuminated! when! the! device! is! held! in! contact! with  
the.object! and! to! collect! light! reflected! from! the! surface  
**of** the! object! and! scatter! it! back! towards! the! area.

Preferably! the-light! source,! which! conveniently! is  
the! tip! of! an! optical.! fibre,! is! arranged! to! illuminate! the  
diffusely! reflective! surface! so! that! light! from! the! light  
source! is! reflected! towards! the! treatment! area!. This! can! be  
achieved! by! diffusing! the! light! with,! for! example, **a** ceramic  
reflector! or! possibly! a! p.t.f.e.! or! etched! diffuser! on! the

-! 5! -

optical! fibre.

|

The! present **invention** also! pro **ides!** a method! of illuminating! an! area! of! an! object! comp! ising! the! steps! of: illuminating! the! area! of! the! o! ject! with! light! from a! light! source! illuminating! a **concave** iffusely! reflective **surface!** maintained! confronting! the! are

positioning! the! diffusely! refl! ctng! surface! with its! edges! in! contact! with! the! objects! that! it! collects light! reflected! from! the! surface! of! th! object! and.! scatters it! back! towards! the! area! and! so! that! t! e! edges! of! the concave! diffusely! reflecting! surface! d! fine! the! area! being illuminated.

The! light! used! may! be! laser! li! ht! as! in! the conventional! PDT! techniques! or! may! be! on-coherent! light! for some! applications. The! diffusely! refl! ctive! surface! may! be the inner,! concave! surface! of a part-s 'nherical,e.g. hemispherical,! shell-like! structure! wi! h! the! optical! fibre and! diffusing! device! attached! in! its! t•p.! In! use,! the! shell is! held! with! its! edges! in! contact! with! the! object! under illumination! so! that! any! light! reflect! =d! off! the! illuminated area! is! collected **and! scattered! back** t **ereto!** by the diffusely! reflective! surface. A! refle•tivity! of! 99%! can! be achieved! by! coating! the! concave! surfac! with! reflective paint,! or! any! suitable! highly! reflecti! e! coating,! e...g.! a ceramic.

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If! the! area! to **be** illuminated! is! smaller! than! the base! area! of! the! hemisphere! then! parts! of! the! area! which! do not **require!** illumination! can be! masked! with! a! highly **reflective!** surface. This **means** that! light! striking! the reflective! surface! is! not! lost **but** is reflected! back! towards the **diffusely** reflective **surface** and! a **eventually-onto!** the area! to! be! illuminated.

It! will! be! appreciated! that! with! the! present invention! the! amount! of! light! delivered! to! the-treatment area! can! be! accurately! determined! since!: none! of! the! light delivered! to! the! area! is! allowed! to! escape..! This! is! because almost! all! of! the! light! reflected! from! the! illuminated! area is! scattered! back! towards! it! by! the! di! fuse! reflective surface! and! since! the! reflective! surface! is! held! in! contact with! the! object,! no! light! can! escape! under! the! edges. Furthermore,! the! use! of! a! diffusing! device! on! the! end! of! the optical! fibre! delivering! the! laser! light! and! the! use! of-the diffusely! reflective! surface! mean! that! the! intensity! of! the illumination! is **substantially** uniform! over! the! whole! of! the treatment! area.

The! invention! also! has! benefit-! for! the! safety! of the! operator! and,! if! it! is! being! used! in! medical! treatment, for! the! patient,! as! once! the! reflective! surface! is! in contact! with! the! body! the! laser! system! is! closed! and! there is! very.! little! risk! of! accidental! injury! to! the! operator! or

to! the! patient! caused! by! escaping! las! r! light.! It! is possible! to! arrange! for! the! laser! or! cther! light! source! only to! be! switched! on! when! the! reflective! surface! is! placed! in contact! with! the **body!** - e.g.! by! a! pressure! sensitive! or temperature **sensitive! switch! or** by! some **other** switching means.

If! desired! the! target! to! be! illuminated! may! be treated! with! an! agent! to! absorb! the! light.! e.g.! a **photodegradable** or! photocensitizing! agent.! For! example where! the! invention! is! to! be! used! in! photodynamic! therapy, e.g.! for! the! treatment! of! cancer,! then! a! suitable! agent which! might! be! preferentially! absorbed! by! certain! cells! e.g. cancerous! cells,! e.g. *HpD* can! be! administered! to! the! patient some! hours! before! the! laser! treatment.! An! accurate! amount of! light! can! then! be! delivered **to** the! treatment! area! and this! allows! the! operator! to! calculate! more! accurately! what depth! of! tissue! may! be! destroyed.! This! not! only! allows better! treatment **of** an **individual** pati! nt! but! also **allows** a better! correlation! of! results! to! treat! ent! conditions! and! so the! best! conditions! for! the! treatment! f! the! cancer! and different! types **of** cancer! may! be! determined! more! easily.

The! invention! is! also! useful! fr! the! treatment! of port! wine! stains, **homeopathic** processe! and! bio-stimulation where! the! fact **that** the **illumination** i uniform **and! defined** allow! better! control! of! the! treatment ! rocess.

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The invention has been described to use in medical treatment, e.g. for It is, however, useful in any process to uniformly illuminate an area and to by reflection from that area. Thus the industrial processes for manufacturing substances e.g. plastic resin composites processes in the manufacture of microchips. In such processes the radiation escapes and that well defined area is that the process can be run economical processes types of electromagnetic radiation optical laser light might be appropriate.

The device may also be useful biological growth of animals or particularly the fact that the illumination is and no radiation is allowed to escape efficiency and economy of the process.

The shape of the reflective surface is not thought to be particularly critical, the prefer red embodiment in this specification uses a hemisphere but other concave shapes can be used.

The size of shell is chosen to be close to the size of the area to be illuminated.

A typical size of shell used for medical purposes

above in relation hotodynamic therapy. here it is desirable avoid losing light device could be used, e.g. for curing or for optical devices e.g. that no light illuminated mean. Clearly for such action other than e.

or promoting larly plants, where accurately defined an improve the

-! 9! -

would! be! a! few! inches! in! diameter,! but  
shells,! e.g.! large! enough! to! cover! the  
may! also! be! used! where! appropriate.! I  
the! reflective! surface! to! be! formed! on  
that! it! can! be **shaped** to! match! the shape! of! the! area! to! be  
**treated.** **These!** allow! the! operator to void treating! areas  
which! do! not! need! treatment.

As! an! alternative! to! using a! diffusing! device! on! the  
end! of! the! optical! fibre,! the! fibre! may! be! mounted! to! direct  
light! onto! a! diffuse! reflector,..! made! from,! e.g.! a! reflective  
ceramic,! mounted! in! front! of! the! diffusely! reflective  
surface! to! reflect! the! light! back! onto! it.

The! apparatus! may! further! comprise! a! deformable  
sheet! of! material! across! the! open! end! of! the! concave  
surface,! e.g.! a! sheet! of! white! rubber! or! synthetic! rubber,  
and! which! has! a! high! reflectivity,! appreciable! transmission  
and! low-absorption. The! absorption! should! be! low! enough! to  
prevent! undesirable! light! loss,! e.g.! ab! ut! 1%,! and! the  
transmission! high! enough! to! allow! sufficient! illumination! of  
the! target! surface.! For! medical! applications! about! 9%! is  
acceptable. The! reflectivity! should! be! for! such  
**applications,**! about! 90%.

The **invention** will! be **further** described by way! of  
**non-limitative! example** with! reference! to the **accompanying**  
drawings! which: -

- 10! -

Figure! 1! is! a! cross-sectional! iew! of! one! embodiment  
of! the! invention;

Figure! 2! is **a! partially! cutawa! view** of! the  
embodiment! of! Fig! 1! in! use;

**Figure! 3! is a schematic! view of a! second! embodiment**  
of! the! invention! in . use;

Figure! 4! shows! a! third! embodimnt! of! the! present  
invention:: and

Figure! 5! shows! a! fourth! embodiment! of! the! invention

As! can! be! seen! by! Fig! 1! the! ap aratus! comprises! a  
light! delivery! device! 1! which! consists! of! a! hemispherical  
relatively! rigid,! plastics! shell! 3! who! e! inside,! Concave  
surface! is! coated! with! a! reflective! coating! 5.! The! coating  
is! a! reflective! paint! or! ceramic! which! provides! a! diffuse  
reflective! surface. It! is! possible! to! achieve! a! -  
reflectivity! as! high! as! 99% or! more! with! such! a! coating.  
The! shell,! intended! for! medical! use! in! PDT! is! about! 5-15cm  
in! diameter! and! about! 1-2mm! thick.

Laser! light! is! supplied! to! the! device! along! an  
optical! fibre! 7,! which! may! be! a! single! fibre! or! a! bundle! of  
fibres. In! this! embodiment! the! fibres! are! teflon! coated! and  
retained! within! a! p.t.f.e.! sheath! 9.! The! fibres! terminate  
at! a! diffusing! element! 11,! which! is! in! this! embodiment! a  
p.t.f.e.! cylinder! or,! alternatively,! a! ceramic! or! etched  
fibre! diffuser! (formed! by! exposure! to! hydrofluoric! acid)

11! -

mounted! in! the **hemispherical** shell. The! fibre! is! connected to! the! shell! by! a! two-part! block! 13! having! a! bore *down* the centre! through! which! the! fibre! and! sheath! pass. **The! fibre** is! trapped! in! an! interference! fit! between! the two parts! of the! block! 13.! In! the! illustrated! embodiment the! diffuser! 11 is! positioned! about! 2cm! below! the! top! of! the! shell.! Light transmitted! down! the! fibre! passes! into! the! diffuser! 11! and is! emitted! from! the! end **of** the! diffuse! in! a! number! of directions. Some! light! will! be! transmitted! directly! to! the treatment! surface,! but! some! light **will** also! be! transmitted towards! the! diffusely! reflective! surface! 5.! Various! light paths! are! shown! in! the! diagram.! Light! striking! the diffusely! reflective! surface! will! be! scattered! therefrom, partly! towards! the! treatment! area! and! part! towards! opposing regions! of! the! reflector.! It! will! be! appreciated, therefore,! that! a! fairly! uniform! illumination! is! achieved within! the! region! defined! by! the! edges! of! the! reflective shell.

Although! not! shown! in! the! diagram,! the! shell! may! be provided! with **a** sensor! and! switch! so! that! the! laser supplying! light! to! the! optical! fibre! 9! is! only! switched! on when! the! shell! is! pressed! into! contact! with! the! surface which! is! to! be! illuminated.! This! results *in* less! chance! of the! patient! or! operator! being! accidentally! exposed! to! laser light! and! thus! improves! the! safety! of! the! apparatus.

- 12.! -

In! Fig.! 2! the! device! is! shown! schematically! in! use on! part! of! a! patient! 15.! This! shows! the! device! used! in! a situation! where! the! area! 17! which! is! to! be! illuminated! is **smaller! than the base area of the reflector.** The **parts** of skin! which! would! undesirably! be! expose! to! the! light! have therefore! been! masked! using! a! reflective! tape! 19, -for example!, **aluminium! tape.** This! means! that! light! supplied to the! delivery! device! 1! which! misses! the **exposed! treatment** area! and! hits! the! tape! is-reflected! back! up! to! the! diffusely reflective! surface! and! scattered! back! towards! the! treatment area.

Figure! 3! shows! a! second embodiment! of! the! invention in! use..! In! this! embodiment! the reflective! shell! 22! is formed! from! a! flexible! plastics! material! so! that! it! may! be deformed! to! cover! a! desired! treatment! area! more! accurately. A! further! feature! of! this! embodiment, **which!** can! also! be! used in! the! other! embodiments! of! the! invention,! is! that! light! is supplied! to! the! device! by! several! optical! fibres! 27 **each** connected! to! a! diffusing! device! 11! and! spaced! over! the surface-of! the! shell!.! This! enables! a! greater! amount! of light! to be delivered! per! unit! time! if! necessary! and! helps in! maintaining! a , substantially! uniform! light! distribution **particularly** in! the! case! where! the! shell! is! deformed.

The! above! embodiments! have! been! described! as! being supplied! with! laser! light! by! an! optical! fibre.! However,! the

- 13! -

invention is! also usable in! other applications! in! which! e.g. ultra! violet! or! infra! red! light! or! any! electromagnetic! wave radiation! are! used.! in! such! applications! the! light! may! be delivered! to! the! delivery! device! using! a! light! guide! e.g. liquid! or! fibre! light! guide! or! other! t! pes! of! radiation guides! or! the! light! source! may! be! moun! ed! in! or! on! the shell.

Figure 4! shows! schematically a! third! embodiment of the invention in! which! light delivered to! the device by an optical! fibre! 9! is! directed! onto! a! ref! ector! 30! in! this! case spherical,! though! other! shapes! may! be! sed,! which! reflects light! back! upon! to! the! diffusely! refle! tive! surface! which, in! turn,! scatters! it! onto! the! treatmen! area.. The! reflector 30,! which! may! be! a! highly! reflective! c! ramic,! is! mounted! on the! shell! 1! by! a! mounting! 32.

Figure! 5! shows! disgrammaticall! a! fourth! embodiment of! the! invention! which! uses! a! reflecto! 1! and! light! delivery system! 9! and! 30! as! in! the! previous! emb·diments,! but! also includes! a! deformable! partly! reflectiv!= partly! transmissive sheet! 50! across! the! open! end! of! the! reflector! which,! in use,! covers! the! target! area.. The! sheer! 50! may! be! a! sheet! of white! rubber! or! synthetic! rubber! and! h-s! a! high! reflectance preferably! greater! than! 17%! and! more! p! eferably! still greater! than! 77% ,! very! low! absorrtion! •referably! less! than 5% and! appreciable! transmission. Typi.al! values! which! have

-! 14! -

been! effective in! practice! are,! for! in! tance,. 90% reflection, 9% transmission and 1% absorption.! This! sheet 50! is **particularly** useful! when! the! dev! ce! is! used! to illuminate! an **uneven! surface!** as it! con orms! or! partly **confirms to that! surface! and! improves** she! uniformity! of! the light! delivered! to! the! target.

5

With! the *invention* it! is! possitl! to! calculate! the amount! of! light! supplied! to! the! treatment! area! much! more accurately! than! with! the! prior! art! devices.! This **is** because **substantially** all! of! the! light! supplied! to! the! device! is eventually! absorbed! by! the! treatment! surface.! None! is allowed! to! escape! —! because! the! reflector! shell! is! placed! in contact! with! the! object! being! illuminated! and! any! light reflected! from! the! treatment! surface! is **eventually** scattered back! by! the! diffuse! reflector! towards! t! e! treatment! surface. Furthermore,! the! fact,! that! virtually! n! ne! of! the! light supplied! to! the! device! is! allowed! to! es! ape! means! that! the device! is! particularly! safe! to! use.

While! the! invention! has! been! de! cribed! in! relation to! the! medical! treatments,! as! discussed! above! it! is applicable! wherever! it! is! required! to! deliver! an! accurate and! uniform! irradiation! to! a! surface,! or! to! substantially!. reduce! the! amount! of! light! lost! from! a! system,! or! to! define the **area** to! which **radiation! should! be! delivered.** The! effect of! this! device! in! minimizing! losses! has benefits! in! that! for

-! 15! -

a! given! total! energy! absorption! requirement! for! a! given  
power! output! of! the! radiation! source,! less! time! will! be  
needed! to! bring! about! that! effect.

- 16! -

CLAIMS

1. Apparatus! to! deliver! a! de! ined! quantity! of  
light! to! a.! surface! comprising! a! light! ource! for  
illuminating! the! surface! and! means! for scattering light  
reflected from! the surface so! that it can! be directed back  
onto! the! surface.

2. Apparatus according! to! claim! 1! wherein! the  
scattering! means! are! adapted! to provide a substantially  
uniform! illumination! of! the! surface.

3. Apparatus! for! illuminatin  
object,! comprising! a! delivery! device! i  
source! for! illuminating! the! area! and! a  
reflecting! surface,! wherein! the! diffus  
is! adapted! to! define! the! area! to! be! it  
device! is! held! in! contact! with! the! obj  
light! reflected! from! the! surface! of! th  
it! back! towards! the! area.

an! area! of! an  
cluding! a! light  
concave! diffusely  
ly! reflective! surface  
uminated! when! the  
ct! and! to! collect  
object! and! scatter

4. Apparatus! according! to! cl! im! 3! wherein! the  
light! source! is! adapted! to illuminate  
reflective! surface! so! that! light! from  
scattered! towards the area of! the! obj!  
he! diffusely  
he! light! source! is

5. Apparatus! according! to! cl  
light! source! is! a! source! of! laser! ligh  
im! 3! or! 4! wherein! the

6. Apparatus! according! to! cl  
im! 3, 4! or! 5! wherein

-! 17! -

the! light! source! includes! an! element! for! distributing! the  
light! onto! the! reflecting! surface.

7. Apparatus! according! to! cl! im! 6! wherein! the  
element! is! a! diffusely! reflecting! body

8. Apparatus! according! to! claim! 6! wherein! the  
element! is! a! p.t.f.e.! cylinder.

9. **Apparatus** according! to! an! one! of! the! preceding  
claims! wherein! the! diffusely! reflectiv! surface! is! the  
concave! surface! of! a! shell-like! struct! re,! the! edges! of! the  
shell! defining! the! area! to! be! illuminated! when! it! is! held! in  
contact! with! the! object.

10. Apparatus! according! to! claim! 9! wherein! the  
concave! surface! is! coated! with! a! reflective! ceramic! to! form  
the! diffusely! relect.ive! surface.

11. Apparatus! according! to! anj one! or! the! claims! 3  
to! 10! further! comprising! a! deformable heet! of! material  
across! the! open-end! of! the! concave! surf ace,! said! material  
**having!** a high' light! reflectance, **apprec**iable! light  
transmission! and! low! light! absorption! flor! the! light! from  
**said** light! source.

12. A! method! of! illuminating! an! area **of** an! object  
comprising! the! steps! of:

**illuminating** the! area! of! the! object! with! light! from  
a! light! source! preferably! a! laser! light! source,! illuminating  
a! concave! diffusely! reflective! surface! maintained

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confronting! the! area,

and! positioning! the! diffusely! reflecting! surface  
with! its! edges! in! contact! with! the! object! so! that! it  
collects! light! reflected! from! the! surf-ce! of! the! object! and  
scatters! it! back! towards! the! area! and! o! that! the! edges! of  
the! concave! diffusely! reflecting! surfa! e! define! the! area  
being **illuminated.**

b

13. A! method! according! to! cia 12! wherein! the  
diffusely! reflecting! surface! is! illumi! ated! by! light  
delivered! by! an! optical! fibre! to! a! dif! user,! e.g.! of! ceramic  
or! a! p.t.f.e.! cylinder,

14. A! method! according! to! claim! 12! or! 13! wherein  
the! area! is! provided! of! with! a! degradable! agent! for  
absorbing! the! light.

15. A! method! according! to! cla 12,13! or! 14,  
wherein! light! from! the! concave! surface! is! transmitted  
through! a! deformable! sheet! covering! th! surface,! the! sheet  
having! properties! of! high! light! reflec! ance,! appreciable  
light! transmission! and! low! light! absor! tion.

FIG. 1

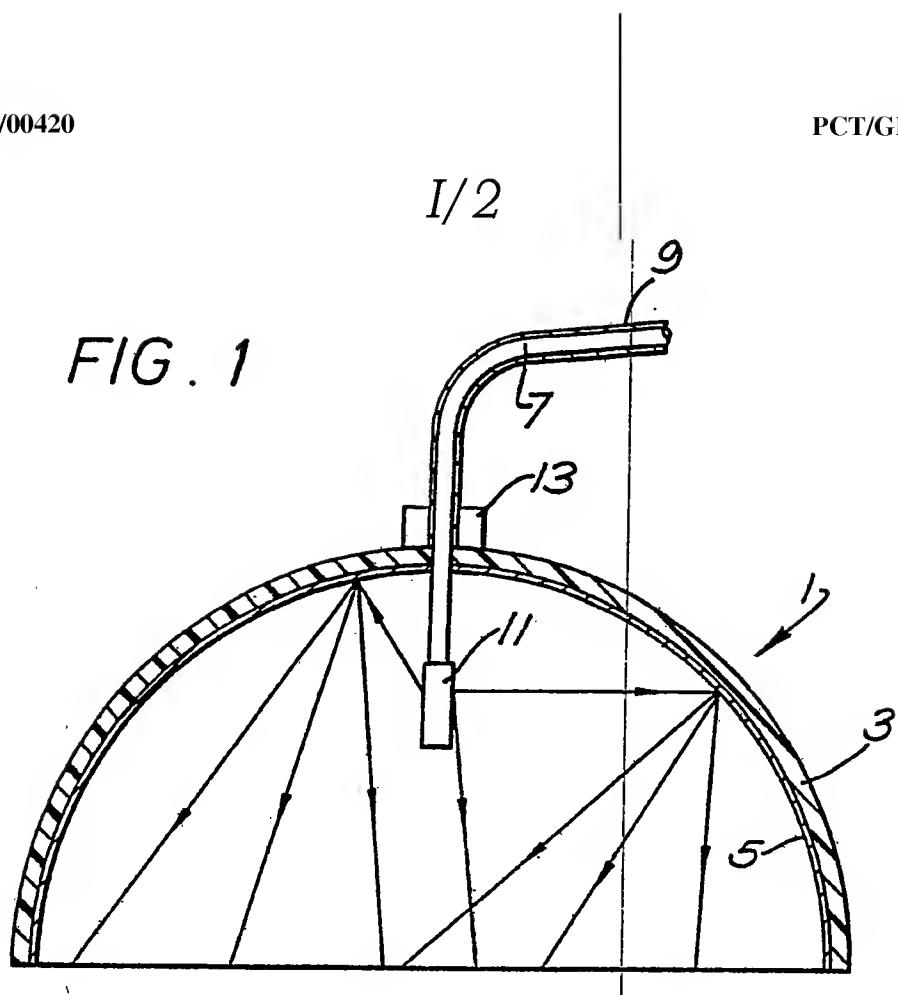
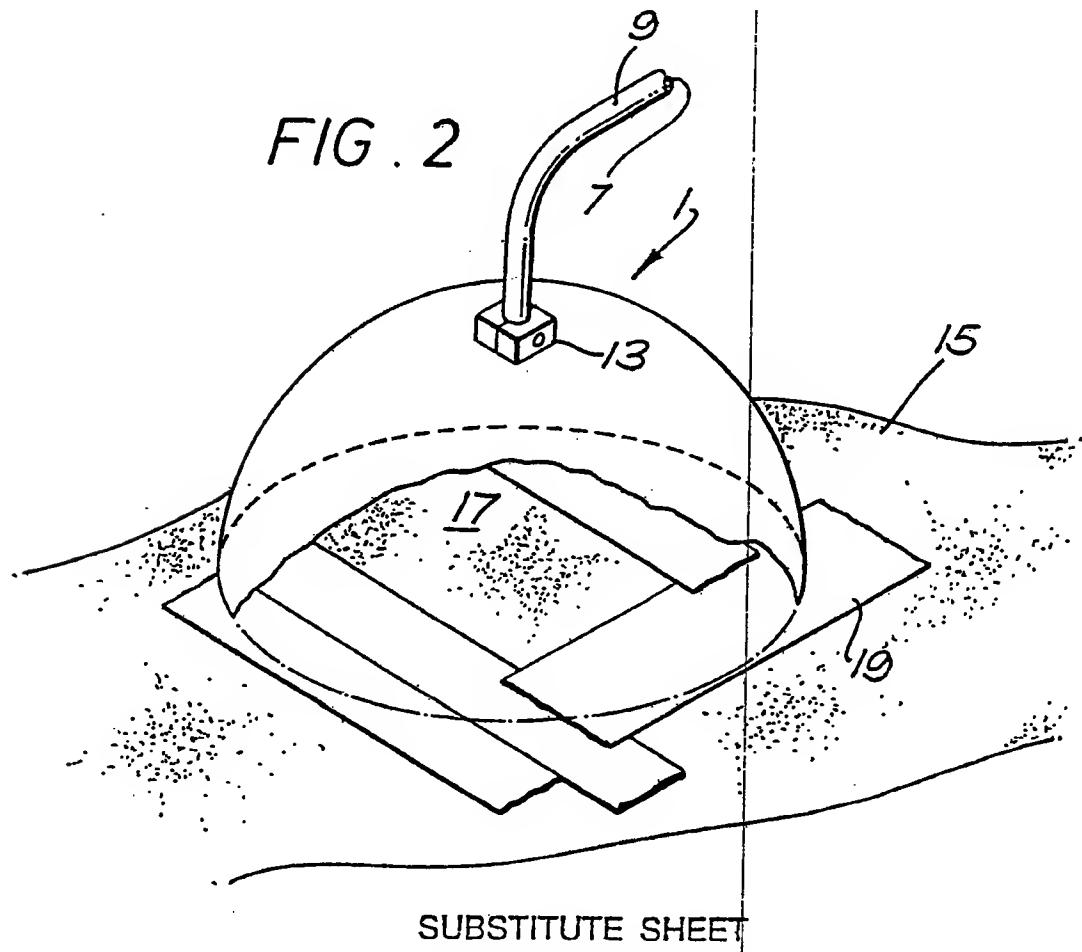


FIG. 2



SUBSTITUTE SHEET

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FIG. 3

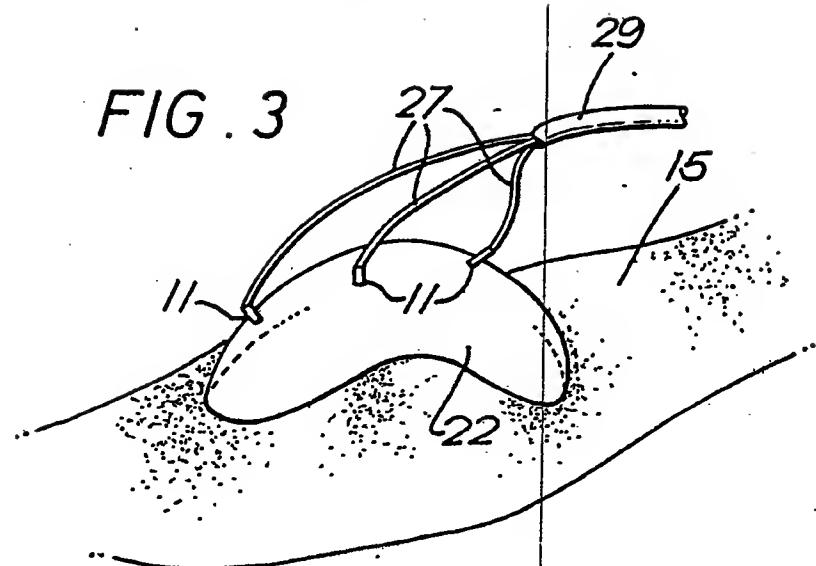


FIG. 4

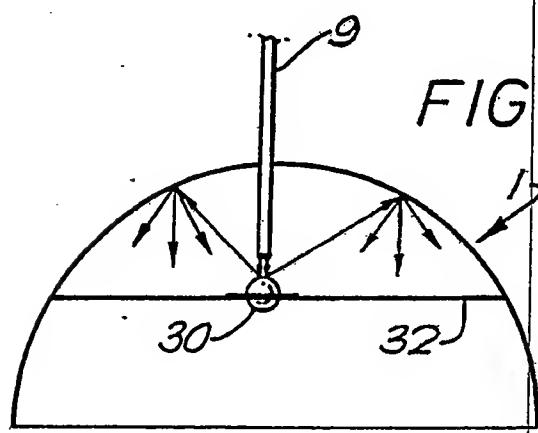
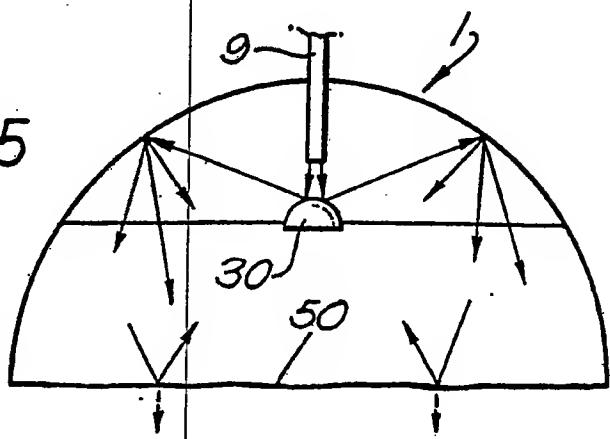


FIG. 5



**INTERNATIONAL SEARCH REPORT**

International Application No PCT/GB 89/00796

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all)			
According to International Patent Classification (IPC) or to both National Classification and IPC <b>Ipc5: A 61 N 5/06</b>			
<b>II. FIELDS SEARCHED</b>			
Minimum Documentation Searched <sup>7</sup>			
<b>Classification System</b>		<b>Classification Symbols</b>	
<b>IPC5</b>		<b>A 61 N, A 61 B</b>	
<small>Documentation Searched other than Minimum Documentation to the Latent that such Documents are Included in the Fields Searched.</small>			
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b>			
<b>Category</b>	<b>Citation of Document, with indication, where appropriate, of the relevant passages</b>	<b>Relevant to Claim No.</b>	
X	FR, A 2591902 (COLLIN) 26 June 1987, see page 3, lines 28-32; page 6, lines 7-11; figure 4 --	1-5, 9, 12	
X	D.E, A, 3300517 (MERSMANN) 26 July 1984, see page 9, lines 12-20; page 52, lines 32-37; page 99, lines 9-33; figures 93-96	1-10, 12	
Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance earlier document but published on or after the international filing date "L" document which may throw doubts on priority/claims or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, user, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document prior to invention document cannot involve a inventive step "Y" document cannot be document menu is in the a "3" document member of the same patent family	men published after the International filing date and not in conflict with the application but understand the principle or theory underlying the of particular relevance; the claimed invention considered novel or cannot be considered to inventive step of particular relevance; the claimed invention considered to involve an inventive step when the is combined with one or more other such document combination being obvious to a person skilled member of the same patent family
<b>IV. CERTIFICATION</b>			
Date the Actual Completion of the International Search <b>18th October 1989</b>	Date at Maflin	of this International Search Report	
International Searching Authority <b>EUROPEAN PATENT OFFICE</b>	Signature of Authorised	<b>T.K. WILLI</b>	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

**GB 8900796**

**SA 30105**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the European Patent Office EDP file on 08/11/89  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family members)	Publication date
FR--A- 2591902	26-06-87	None	
'DE-A- 330(1517	26-07-84	None	